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SURVEY OF THE OCEAN FISHERIES OFF DELAWARE BAY--

SUPPLEMENTAL REPORT, 1954-57

SPECIAL SCIENTIFIC REPORT–FISHERIES No. 347

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

The survey area

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SURVEY OF THE OCEAN FISHERIES OFF DELAWARE BAY--

SUPPLEMENTAL REPORT, 1954-57

By
John W. Reintjes and Charles M. Roithmayr
Fishery Research Biologists
Bureau of Commercial Fisheries

ABSTRACT

This is a final, supplemental report of a survey of the ocean fisheries off Delaware Bay, including the coastal waters lying between Barnegat, New Jersey and Chincoteague, Virginia, for the period 1954-57. Because of their seasonal nature, data pertaining to the winter fisheries (offshore otter trawl, trawl line, and gill net) were included from July 1953 through May 1958.

Measurements of catch, catch per unit effort, and total fishing effort for the major fisheries of the area (excluding the menhaden purse-seine fishery) indicate that the otter-trawl and pot fisheries have remained relatively stable during the period. The surf-clam fishery has shown an increased production, but a decline in apparent abundance. Minor fisheries, including pound net, gill net, trawl line, hand line, and purse seine for food fish, have dwindled in importance, and some are near extinction.

Recommendations concerning utilization of the fishery resources of the area and proposed studies, should waste disposal in the coastal waters be contemplated, are included.

In view of a proposal to discharge certain chemical wastes into the ocean waters off Delaware Bay, the U. S. Fish and Wildlife Service was concerned with the possible effect of such wastes on the fish stocks of the area. Accordingly, a survey of the commercial and sport fisheries was conducted in the ocean waters off southern New Jersey, Delaware, and Maryland. Field studies were begun in 1952 and continued through May 1958. Waste disposal was not initiated, and the study was terminated when the likelihood of the proposed disposal seemed remote.

This report summarizes data compiled for the years 1954 through 1957 and supplements an earlier report by June and Reintjes (1957) for the period 1946-53. Because operations of the offshore otter-trawl, trawl-line, and gill-net fisheries overlap calendar years, pertinent data on these fisheries were included from July 1953 through May 1958.

The objectives of the study were to determine the following: (1) fishing areas and seasons, (2) abundance of fish and intensity of fishing in terms of individual

species or groups of similar fishes, (3) value of investment and catch, and (4) changes occurring in fishing methods and equipment.

The geographical area considered included the ocean waters of the Atlantic coast between Barnegat Lightship and Winter Quarter Lightship, from the shore to the 100-fathom curve (fig. 1). The area delineates the normal fishing range of commercial and sport-fishing vessels operating out of southern New Jersey, Delaware, and Maryland ports.

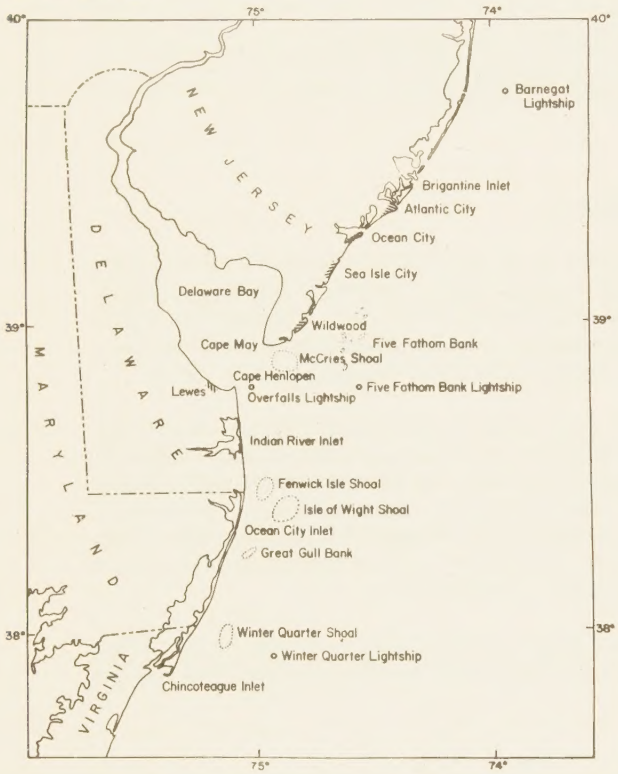

Figure 1.--Major fishing ports and grounds

Because recent estimates (1957) of the replacement value of the various fishing fleets closely approximated those given in the previous report (June and Reintjes 1957), revised estimates are not given. The value of the catch to the fishermen has not been included in this report, but may be obtained from reports published elsewhere (Anderson and Power, 1956 and 1957; Power, 1958 and 1959).

Many persons contributed to the survey--the hundreds of fishermen who willingly kept daily accounts of their fishing activities, the dock owners who made available their catch records, the cannery and processing-plant operators who provided catch records and assisted in making the fishing logbook system a success--to all these the authors are grateful. The cooperation of the personnel of the University of Delaware Marine Laboratory, the New Jersey Division of Fish and Game, and the Maryland Department of Research and Education is acknowledged.

Robert M. Livingstone, Jr. and Roy N. Vickery assisted in the collection and tabulation of catch and logbook data.

MAJOR COMMERCIAL FISHERIES

The major commercial fisheries within the survey area are (1) menhaden purse seine, (2) otter trawl, (3) surf clam, and (4) pot. The combined yield of these fisheries, in pounds or value, accounts for over 99 percent of the fish production within the area. Over 95 percent of the catch, by weight, consists of Atlantic menhaden which is processed into fish meal, oil, and solubles.[1] Landings of the otter-trawl fishery account for roughly 20 million pounds annually. Most of the species taken by this gear (fluke, porgy, weakfish, and sea bass) are marketed fresh, either in the round, or as fillets. The surf-clam fishery ranks second in the production of fishery products consumed directly by man. The commercial production of surf clams for canning purposes began in 1950, and expansion of this fishery has continued through 1957. The pot fishery for sea bass, although least in size among the major fisheries, produces approximately 2 million pounds annually for the fresh-fish market. Excluding menhaden, these major commercial fisheries contribute about 40 million pounds of edible fishery products annually; they supply most of the fresh fish marketed in the metropolitan areas of the Middle Atlantic States and nearly the entire surf-clam production of the United States.

OTTER-TRAWL FISHERY

The otter-trawl fishery is comprised of two resident fleets: (1) an inshore fleet of small and medium-sized vessels, under 50 feet in length, which make daily trips to

[1] A discussion of the menhaden purse-seine fishery is not included in this report. Information concerning the fishery is available in the published reports of the Menhaden Investigations, Beaufort, N. C.

nearby fishing grounds, and (2) an offshore fleet of larger vessels, over 50 feet in length, which usually fish from 2 to 6 days each trip farther out along the Continental Shelf. The two fleets fish for many of the same species (cf. tables 1 and 2), but fishing is done, primarily, in different seasons (cf. tables 3 and 4) and on different grounds (cf. figs. 2 and 3): the inshore fleet fishes from May through November within the 15-fathom curve, and the offshore fleet fishes from October through May outside the 15-fathom curve. In late summer and early fall both fleets may fish on concentrations of fluke, porgy or scup, weakfish or gray sea trout, and croaker which appear on the banks inside the 15-fathom curve.

FISHING GROUNDS

Detailed information on the grounds fished by the inshore and offshore trawl fleets was obtained from logbook records kept by vessel captains. The number of vessels which furnished complete logbook records for the 4-year period amounted to about 11 percent of the inshore fleet and 22 percent of the offshore fleet. Resulting data were tabulated by fleet for each year (1954-58), but since no significant changes were evident during the period, the average fishing effort in each subarea by each fleet was calculated (in percent) and is shown graphically in figures 2 and 3. Total effort was estimated from the ratio of landings with recorded locality of capture data by the sample fleet to the total landings.

About 92 percent of the fishing by the inshore fleet was conducted within the 10-fathom curve (fig. 2). Five-Fathom Bank and grounds immediately off the mouth of Delaware Bay together accounted for approximately 67 percent of the total fishing effort, with contiguous areas sustaining most of the remainder.

Table 1.--Species composition, inshore otter-trawl landings

[in thousands of pounds]

Species	Year				Mean percent
	1954	1955	1956	1957	
Fluke	3,638	2,842	2,670	2,939	41.1
Weakfish	1,414	1,046	725	1,215	15.0
Porgy	1,725	908	554	513	12.6
Whiting	1,078	764	285	708	9.6
Croaker	693	1,126	271	211	7.8
Red hake	109	233	121	356	2.8
Butterfish	235	113	251	183	2.7
Sea bass	130	220	160	97	2.1
All others	484	707	313	357	6.3
Total	9,506	7,959	5,350	6,579	--

Table 2.--Species composition, offshore otter-trawl landings

[in thousands of pounds]

Species	Year				Mean percent
	1954	1955	1956	1957	
Porgy	5,586	3,124	2,413	4,123	39.9
Fluke	2,861	2,484	3,474	1,839	27.9
Sea bass	1,349	1,610	1,255	1,262	14.3
Butterfish	918	646	826	838	8.4
Lobster	320	588	329	335	4.1
Squid	107	86	94	216	1.3
All others	427	426	436	273	4.1
Total	11,568	8,964	8,827	8,886	--

Table 3.--Monthly inshore otter-trawl landings

[in percent]

Month	Year				Mean
	1954	1955	1956	1957	
Jan	4.0	5.3	0.6	7.0	4.2
Feb	0.5	0.2	---	1.8	0.6
Mar	0.9	0.3	1.0	1.6	1.0
Apr	5.4	5.6	4.3	5.6	5.2
May	15.7	13.2	12.9	16.1	14.5
June	16.0	13.0	17.2	16.0	15.6
July	9.7	8.0	10.0	7.0	8.7
Aug	8.2	13.2	15.7	13.4	12.6
Sept	14.1	13.6	15.1	14.7	14.4
Oct	9.4	10.5	7.9	6.3	8.5
Nov	8.0	9.6	9.4	6.6	8.4
Dec	8.0	7.5	6.0	3.9	6.4

Table 4.--Monthly offshore otter-trawl landings

[in percent]

Month	Season					Mean
	1953-54	1954-55	1955-56	1956-57	1957-58	
July	1.3	4.6	1.6	0.2	0.9	1.7
Aug	0.6	1.4	2.6	2.4	1.1	1.6
Sept	3.7	10.1	3.9	3.4	5.4	5.3
Oct	9.0	7.6	8.7	8.7	10.1	9.0
Nov	14.0	13.2	10.3	9.5	9.7	11.3
Dec	9.1	6.7	8.1	13.0	9.9	9.4
Jan	8.8	7.2	15.3	7.1	9.9	9.6
Feb	9.3	10.8	11.2	11.2	9.5	10.4
Mar	14.2	12.8	13.4	15.9	9.8	13.2
Apr	14.8	15.1	13.1	16.1	16.6	15.1
May	8.1	7.6	8.7	9.5	17.2	10.2
June	7.1	2.7	3.0	2.9	---	3.1

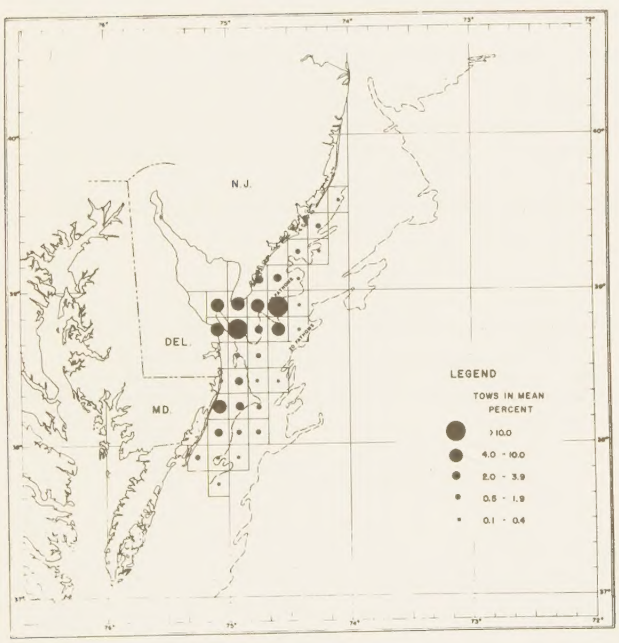

Figure 2.--Distribution of fishing effort by the inshore otter-trawl fleet, 1954-57.

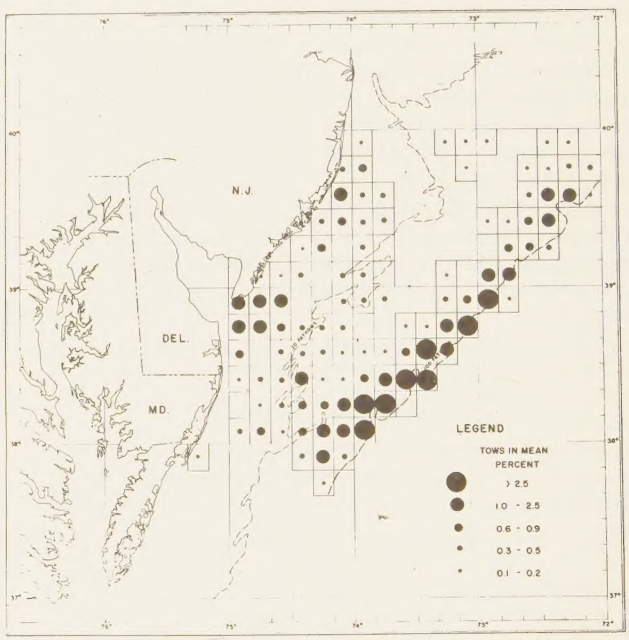

Figure 3.--Distribution of fishing effort by the offshore otter-trawl fleet, 1953-58.

Fishing effort by the offshore fleet was expended along the edge of the Continental Shelf, with heaviest fishing (approximately 36 percent) occurring in the immediate vicinity of marked indentations of the 100-fathom curve (fig. 3). About 8 percent of the offshore otter-trawl effort was spent on the inshore grounds inside the 10-fathom curve, with most of the fishing conducted on Five-Fathom Bank and in contiguous waters.

CATCH

During the 4-year period, 1954-57, the average annual yield of the combined

otter-trawl fishery was 16.9 million pounds. The greatest annual production occurred in 1954 when 21 million pounds were reported for the area.

Landings by the inshore fleet (table 1) showed a recent peak in 1954 (9.5 million pounds), while in 1956, in spite of an increase in fleet size (due to the shifting of vessels from surf-clam dredging to otter trawling), the catch (5.4 million pounds) reached its lowest level within a decade.

Offshore otter-trawl landings during the period fluctuated markedly (table 2). The peak catch of 11.5 million pounds in the 1953-54 season was over $1\frac{1}{2}$ times that of the 1956-57 season (7.4 million pounds). Partial records for the 1958-59 season suggested a record year, with nearly 7 million pounds landed through May.

Offshore otter-trawl landings were summarized by calendar year in table 2 to afford a direct comparison with the inshore otter-trawl landings. All other compilations for the offshore fishery are by fishing year, July-June (see tables 4 and 7 and fig. 5).

Examination of tables 1 and 2 shows that fluke, weakfish, and porgy, on the average, accounted for about 69 percent of the annual inshore landings, whereas porgy, fluke, and sea bass constituted

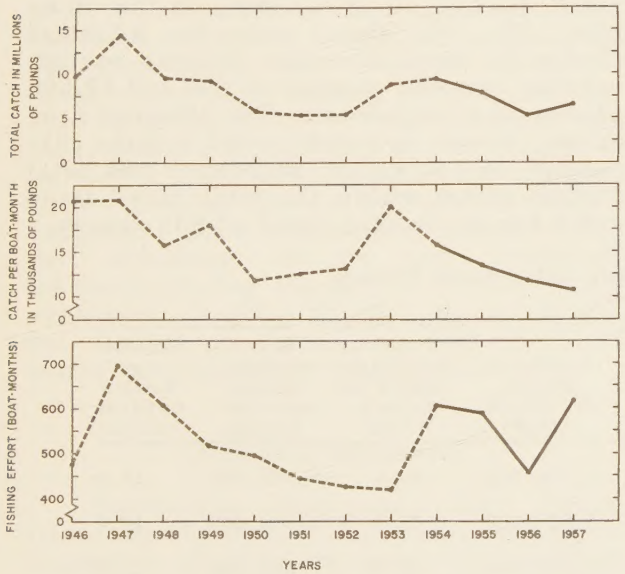
TOTAL CATCH IN MILLIONS OF POUNDS
CATCH PER BOAT-MONTH IN THOUSANDS OF POUNDS
FISHING EFFORT (BOAT-MONTHS)
1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957
YEARS

Figure 4.--Total catch, catch per boat-month, and fishing effort, inshore otter-trawl fishery, 1946-57.

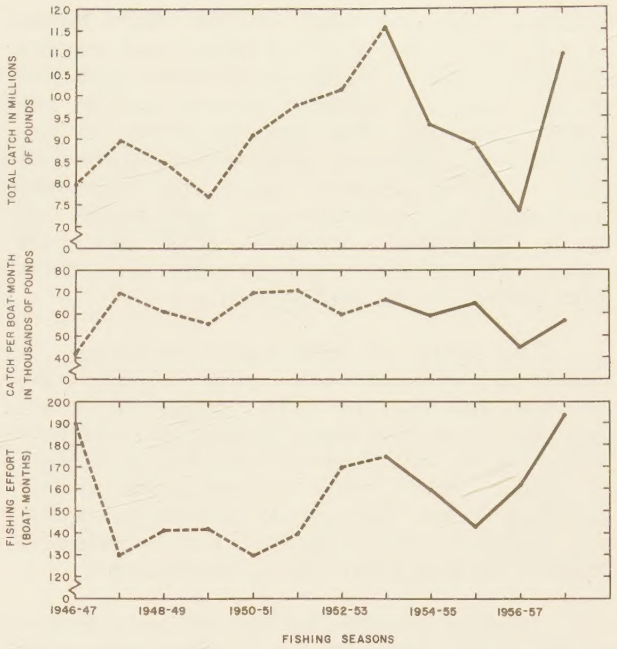
TOTAL CATCH IN MILLIONS OF POUNDS
CATCH PER BOAT-MONTH IN THOUSANDS OF POUNDS
FISHING EFFORT (BOAT-MONTHS)
1946-47 1948-49 1950-51 1952-53 1954-55 1956-57
FISHING SEASONS

Figure 5.--Total catch, catch per boat-month, and fishing effort, offshore otter-trawl fishery, 1946-58.

82 percent of the annual offshore catch during the 4-year period. In certain years (1954-55) whiting and croaker contributed substantially to the landings of the inshore otter-trawl fleet. In the offshore landings, butterfish was the most important minor species, averaging just under a million pounds a year. Composition of the inshore and offshore catches also shows the occurrence of two major species, fluke and porgy. Of the two, fluke was of greater importance, with highest landings made in 1954 (6.5 million pounds) and the smallest in 1957 (4.8 million pounds). Combined landings of porgy also were highest in 1954 (7.3 million pounds), but lowest in 1956 (3.0 million pounds).

The otter-trawl fishery is governed largely by the apparent seasonal movements of the principal species exploited. Fluke, porgy, sea bass, and butterfish are captured in the inshore waters from late spring until early fall and in the offshore waters, near the edge of the Continental Shelf, during the intervening colder months. Weakfish and croaker are caught in greater numbers in middle Atlantic waters in summer, while in early spring and late fall, they appear in greatest catchable concentrations from Delaware Bay southward to the Carolinas.

Whiting and red hake, on the other hand, are found in the Gulf of Maine and waters off Cape Cod in summer but are captured in the middle Atlantic waters during the colder months. The activities of the inshore and offshore otter-trawl fisheries thus are dependent upon the apparent seasonal movements or migrations of these principal species. The seasonal nature of the fisheries may be seen from data presented in tables 1-4.

The bulk of the trawl landings of northern lobster are made during the summer months. Vessels engaged in fishing for this species employ a modified otter trawl with heavy shackles, foot-rope of chain (often with rollers), and sturdy chaffing gear. Fishing is conducted along the uneven, rocky slope of the Continental Shelf in depths from 90 to 125 fathoms.

Certain vessels in the offshore otter-trawl fleet convert to scallop dredging during the summer months when trawling for finfish on the offshore grounds is relatively unproductive. Because of their high market value, scallops contribute an important share of the income of the fishermen and vessel owners. Landings of scallop meats at southern New Jersey ports for the 1954-57 period are shown in table 5. Landings in 1955 reached the highest peak since vessels began exploiting the middle Atlantic beds in 1948.

Table 5.--Scallop landings

Year	Pounds	Year	Pounds
1954	130,000	1956	433,000
1955	617,000	1957	267,000

ANALYSIS OF DATA

Methods of analyzing the otter-trawl catch data follow those given in the previous report (June and Reintjes, 1957); however, the following corrections and clarification are necessary: (1) The seasonal period chosen for the analysis of the inshore trawl fishery was incorrectly stated as "May through October"; it should have read "May through November." The seasonal nature of the fishery is obvious from the data given in tables 3 and 4. Approximately 90 percent of the landings by each fleet fall within the prescribed period. (2) To be included in the "select fleet" used in the analysis, (a) an inshore vessel had to fish 3 months and an offshore vessel had to fish 4 months during the season, and (b) the months during which landings were made had to be the same between adjacent years. Summary data for the analyses are given in tables 6 and 7.

In figures 4 and 5 are plotted measurements of total catch, catch per unit of effort (boat-month), and total fishing effort for the inshore and offshore otter-trawl fleets. To permit comparison, data for the earlier period, 1946-53, are shown by dashed lines. Catch per unit of effort in the inshore fleet (fig. 4) shows a marked downward trend which had its beginning in 1953. Increased fishing effort, in part, was responsible for the slight increase in total catch in 1957. Catch per unit of effort in the offshore fleet, on the other hand (fig. 5), shows only the slightest downward trend over the 12-year period, varying between roughly 42,000 and 72,000 pounds per boat-month. The effect of economic factors upon total catch and the calculated measures of abundance and total fishing effort within the otter-trawl fisheries are beyond the scope of this report.

Table 6.--Summary data, inshore otter-trawl fishery

Year	Estimated total number of vessels	Number of vessels in select fleet	Percentage of total used in analysis	Estimated total catch in pounds	Catch in pounds of select fleet	Percentage of total landed by select fleet	Total pounds landed outside season	Percentage landed outside season
1954	68	40	58.8	9,506,000	4,384,000	46.1	1,787,000	18.8
1955	84	45	53.6	7,959,000	6,815,000	85.6	1,504,000	18.9
1956	92	49	53.3	5,350,000	4,376,000	81.8	637,000	11.9
1957	118	44	37.3	6,579,000	4,408,000	67.0	1,309,000	19.9

Table 7.--Summary data, offshore otter-trawl fishery

Season	Estimated total number of vessels	Number of vessels in select fleet	Percentage of total used in analysis	Estimated total catch in pounds	Catch in pounds of select fleet	Percentage of total landed by select fleet	Total pounds landed outside season	Percentage landed outside season
1953-54	66	16	24.2	11,518,000	8,084,000	79.3	641,000	5.6
1954-55	62	15	24.2	9,330,000	6,918,000	74.1	1,503,000	16.1
1955-56	74	16	21.6	8,878,000	6,488,000	73.1	717,000	8.1
1956-57	58	17	29.3	7,357,000	4,648,000	63.2	442,000	6.0
1957-58	60	20	33.3	10,906,000	7,163,000	65.7	787,000	7.2

SURF-CLAM FISHERY

A commercial surf-clam fishery developed in the coastal waters of New Jersey, Delaware, and Maryland following explorations in 1949 which disclosed extensive virgin beds of these large mollusks. Prior to the establishment of processing plants in the area, the annual catch of less than 50,000 bushels was utilized entirely for bait. Since the beginning of the fishery for canning purposes, surf-clam production has increased each year, reaching a high of 967,000 bushels in 1957 (upper panel fig. 7).

During the recent expansion of the fishery, most of the vessels employed were small inshore otter trawlers which had been converted to hydraulic dredging. These gradually were replaced by larger vessels recruited mostly from the oyster and shrimp fleets of the Atlantic and Gulf coasts. In addition to the increase in vessel size, improvements in dredges, hoses, pumps, engines, and other auxiliary equipment have been made, with the result that efficiency of the fleet increased markedly during the period 1954-57. Data presented in table 8 show the growth of the fishery in terms of fleet size and annual production for this period.

FISHING GROUNDS

Productive surf-clam beds extend from Atlantic City, N. J., to Winter Quarter Lightship off Chincoteague, Va. Grounds most heavily fished are located off the mouth of Delaware Bay in the vicinity of Five-Fathom Lightship (fig. 6). Areas

Figure 6.--Distribution of fishing effort by the surf-clam fleet, 1954-57.

of heavy fishing (more than 10.0 percent per unit area) received 35.8 percent of the total effort; moderate fishing (2.0 - 9.9 percent), 45.7 percent; and light fishing (0.1 - 1.9 percent), 17.9 percent. In general, fishing during the period 1954-57 extended farther offshore and southward along the 20-fathom contour than in the previous 4 years (June and Reintjes, 1957). Surf clam beds located off Indian River, Del., and Ocean City, Md., were fished intensively during the later period. In addition, beds in the vicinity of Atlantic City, N. J., which heretofore received little attention were heavily exploited in 1957.

Table 8.--Summary data, surf clam fishery

Year	Total number of vessels	Number of vessels in select fleet	Percentage of total used in the analysis	Total catch in bushels	Catch by vessels in select fleet in bushels	Percentage of total catch landed by select fleet
1954	70	33	47.1	818,000	428,000	52.3
1955	71	43	60.6	824,000	514,000	62.4
1956	82	33	40.2	932,000	406,000	43.6
1957	102	34	33.3	967,000	448,000	46.3

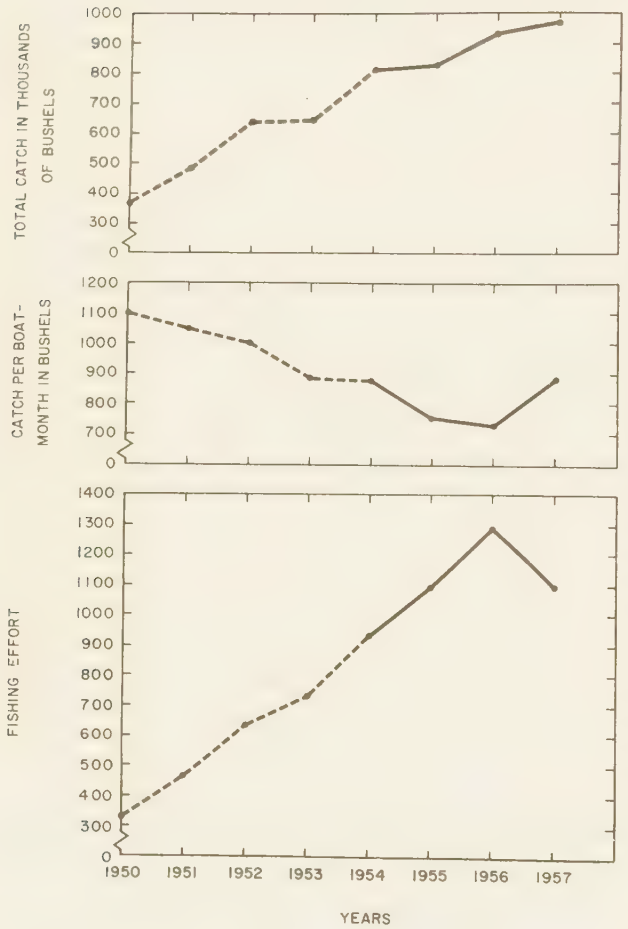

Figure 7.--Total catch, catch per boat-month, and fishing effort, surf-clam fishery, 1950-57.

Logbook records which furnished data for the above compilations were obtained from about 25 percent of the vessels in the fleet. Estimates were derived from the ratio of landings with recorded locality of capture to total landings.

ANALYSIS OF DATA

Methods of analyzing the surf-clam catch data are similar to those given for the otter-trawl fishery. Vessels were included in the "select fleet" only if landings were made during the same 5 months in 2 successive years. A method of "linkage" was established using 1950 as the base year (June and Reintjes, 1957).

Total catch, catch per unit effort, and total fishing effort are shown in figure 7. Comparable data for 1950-53 are shown by a dashed line. Except for 1957, catch per unit effort has declined steadily since the beginning of the fishery, while fishing effort has increased steadily. To some extent, the decline in catch per unit in recent years may be due to the daily boat-limit imposed by the canneries. In 1957, for example, when the quota was relaxed or resolved, individual vessel landings increased. However, despite any artificial effects resulting from the imposition of a limit, the calculated index furnishes a reasonable measure of clam abundance on the grounds.

POT FISHERY

The 30-year-old pot fishery for sea bass expanded in 1954 when over 12,000 pots were fished. Annual production which in the previous 2 years exceeded 2 million pounds, however, did not increase proportionately with increased effort. Total catch, catch per unit effort, and total fishing effort are shown in figure 8. Date for 1946-53 are shown by dashed lines, for 1954-57 by solid lines. Increased yields in 1952, 1953, and 1956 appear to be the

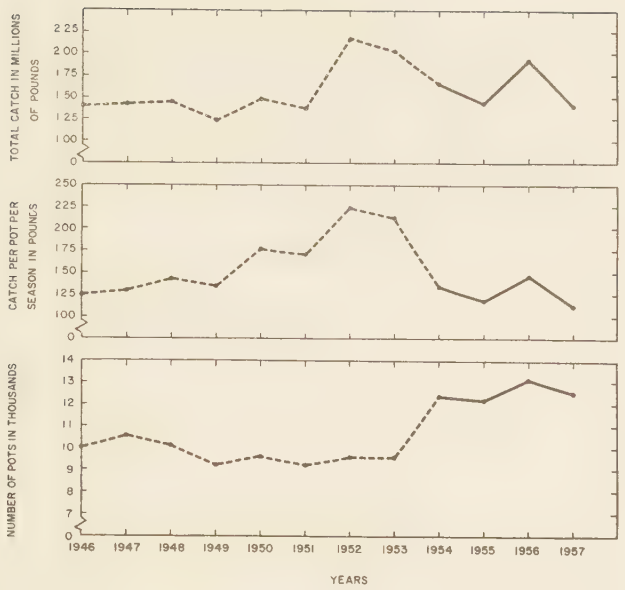

Figure 8.--Total catch, catch per pot, and total number of pots, pot fishery, 1946-57.

result of increased abundance of sea bass rather than increased effort. The data further suggest that 10,000 pots may be an optimum number for the grounds being fished.

Sea bass accounted for approximately 98 percent of the pot catch in the area; the remainder was composed of tautog, red hake, conger eel, and northern lobster.

No changes in species composition, gear, method of fishing, or fishing grounds were apparent during the period.

MINOR COMMERCIAL FISHERIES

Minor fisheries that once contributed substantially to finfish production in the area are: (1) purse seine for food fish, (2) pound net, (3) drift gill net, (4) trawl line, and (5) hand and troll lines. Although these fisheries are still being conducted, all have dwindled in importance, and some are on the verge of disappearance. While a number of factors have contributed to their decline, the following developments or considerations appear to be most pertinent: (1) a decline in the abundance of important migratory species, such as mackerel, weakfish, croakers, cod, and bluefish; (2) changes in the distribution pattern of a number of species; (3) competition from more efficient mechanized gears; and (4) unfavorable economic differential caused by high operating costs and low market demand. Judging from the fact that most of the vessels, gear, and other equipment have become obsolescent, it is doubtful that these fisheries will expand in the immediate future, even though a number of the above factors were to operate favorably.

PURSE-SEINE FISHERY FOR FOOD FISH

The purse-seine fishery for food fish declined from a yield of over 2.5 million pounds in 1954 to 326,000 pounds in 1957. During the past several years, only one vessel operated sporadically from May to November when fishable schools of porgy and weakfish appeared in the shallow, coastal waters. Species composition of the catch is shown in table 9.

No purse-seine fishery for mackerel occurred in the area from 1954 through May 1958.

POUND-NET FISHERY

The pound-net fishery continued to decline during the period (see June,1956), with only three companies now operating within the survey area. Nets were fished from April through November. Species composition of the catch, in order of importance, is given in table 10 ("all others" included black drum, bluefish, bonito, croaker, flounders, king whiting, little tuna, porgy, sea bass, sea herring, sea robin, sea turtle, shad, spot, and whiting). Annual landings fell below the preceding 5-year average of 1.1 million pounds, however, less than half as many nets were operated during the period 1954-57. High operating costs and the increased occurrence of nonmarketable species in the catch have depressed the fishery to the point of near extinction within the area.

DRIFT GILL-NET FISHERY

The drift gill-net fishery historically depended upon midwinter and early spring runs of mackerel, as the fish migrated along the coastal shelf. As elsewhere, the occurrence and abundance of mackerel within the area has shown marked fluctuations over the last 30 years, and during the past few years, the fishery has been relatively unproductive. Annual landings from 1954

through 1958 ranged between 11,900 and 70,400 pounds, with the peak occurring in the season of 1956-57. The catch by species is given in table 11. Prior to 1954, mackerel

Table 9.--Species composition, purse-seine fishery for food fish [in pounds]

Species	Year				Mean percent
	1954	1955	1956	1957	
Porgy	2,282,000	616,000	640,000	139,000	82.0
Weakfish	256,000	102,000	167,000	175,000	15.6
Bluefish	33,000	10,000	8,000	12,000	1.4
All other	19,000	3,000	23,000	--	1.0
Total	2,590,000	731,000	838,000	326,000	--

Table 10.--Species composition, pound-net fishery [in pounds]

Species	Year				Mean percent
	1954	1955	1956	1957	
Weakfish	309,100	309,900	308,300	384,500	54.8
Butterfish	120,800	103,200	122,600	163,500	21.3
Menhaden	11,100	34,000	54,900	64,800	6.9
Squid	36,000	8,000	3,500	5,200	2.2
Mackerel	12,200	8,100	11,000	1,200	1.4
All other	64,800	61,100	54,100	140,900	13.4
Total	554,000	524,300	554,400	760,100	--

Table 11.--Species composition, drift gill-net fishery [in pounds]

Species	Season					Mean percent
	1953-54	1954-55	1955-56	1956-57	1957-58	
Mackerel	306,800	28,200	5,100	34,100	10,000	76.3
Weakfish	300	6,100	34,200	24,800	---	13.0
Whiting	6,500	8,600	700	700	700	3.4
Menhaden	7,100	4,500	2,000	4,100	---	3.5
Sea herring	1,700	100	100	1,100	800	0.8
All other	7,000	200	1,800	5,600	400	3.0
Total	329,400	47,700	43,900	70,400	11,900	---

comprised over 90 percent of drift gill-net landings, while all other species, principally weakfish, whiting, Atlantic menhaden, sea herring, and sharks, made up the remainder of the catch. Interviews with fishermen indicated that more recently, sea herring and Atlantic menhaden have contributed an increased share of the catch, but since there is little or no market demand for these species during the winter months, only very small quantities are brought ashore and sold for bait. Due to the virtual disappearance of mackerel, the few remaining gill-net fishermen recently have begun the practice of setting their nets in the shallow-water channels close inshore where weakfish occur in concentration at certain times.

TRAWL-LINE FISHERY

A winter trawl-line fishery, principally for cod, is conducted in the area from late November until early April. The major fishing grounds are those utilized during the summer by the sea bass pot fishermen and comprise the rocky, uneven slopes, between roughly 8 and 15 fathoms.

Total trawl-line landings, shown in table 12, do not reflect fish abundance for several reasons. Low prices, poor market demand, high operating costs, and the poor fishing season of 1953-54 all have contributed to a variable expenditure of fishing effort. Furthermore, since the survey area marks the southern edge of its distribution in the western Atlantic, cod shows marked variations in occurrence. The net result of these factors is that, in recent years, many trawl-line fishermen have turned to other fisheries for their livelihood.

Table 12.--Species composition, trawl-line fishery [in pounds]

Season	Cod	All other	Total
1953-54	5,100	300	5,400
1954-55	426,300	3,900	430,200
1955-56	674,700	1,600	676,300
1956-57	235,300	6,800	242,100
1956-58	368,100	1,100	369,200
Mean percent	99.2	0.8	--

HAND-AND TROLL-LINE FISHERIES

Commercial hand- and troll-line fishing from small skiffs and power boats contributes relatively little to the commercial foodfish production within the area. During 1954-57, average annual production by these gears amounted to 188,000 pounds. The bulk of the landings were made by casual and part-time fishermen regularly employed in some other fishery or by sport fishermen with catches exceeding their personal wants.

Species composition of the hand-line catch (table 13) shows that weakfish generally accounted for nearly one-half of the landings. In 1955, however, croaker dominated for the first time since 1949. In contrast, over 90 percent of the troll-line catch for the period consisted of bluefish.

SPORT FISHERY

The recreational or sport fishery represents an important part of the fishing activities within the survey area. An estimated 4 million pounds of fish are landed annually by the party- and charter-boat fleets.

The bulk of the ocean sport-fishing fleet is comprised of party, charter, and private boats. Few, if any, rowboats venture out of the bays and inland tidal waters. Surf fishing occurs on all the open beaches, but contributes little to the total catch.

Surveys within the area were confined to charter and party boats for hire, and no adequate methods were developed to estimate the catch or effort of private boats. Alperin[2] estimated that 27 percent of the sport fishing man-hours in the New York Marine District were expended from private boats, as compared with 35 percent

[2] Marine sport fishery statistics program in New York. By Irwin M. Alperin, New York Conservation Department; Atlantic States Marine Fisheries Commission, minutes 14th Annual Meeting (1955), no pagination (mimeo.).

Table 13.--Species composition, hand- and troll-line fisheries [in pounds]

Species	Year				Mean percent
	1954	1955	1956	1957	
Hand line					
Weakfish	10,100	13,000	7,900	15,000	42.1
Fluke	3,700	1,800	1,700	3,300	9.6
Porgy	2,000	9,400	300	1,700	12.3
Croaker	200	23,700	700	800	23.2
Sea bass	200	1,600	700	100	2.4
All other	4,000	3,200	1,300	2,800	10.3
Total	20,200	52,700	12,600	23,700	--
Troll line					
Bluefish	124,100	153,000	157,100	83,700	92.7
Bonito	13,900	6,300	6,700	5,100	5.7
All other	1,600	2,800	3,700	400	1.5
Total	139,600	162,100	167,500	89,200	--

from open (party) and charter boats combined. It does not appear that private boat fishing within the present survey area amounts to over one-fourth of all fishing activities, as was estimated in the New York Marine District. Thus increasing the estimate of sport-fishing production within the area to 7 million pounds, to include private fishing, appears reasonable.

Information pertinent to the Ocean City, Md., fishery was collected by the authors. Data concerning New Jersey and Delaware were obtained from the state agencies conducting the surveys under the auspices of the Dingell-Johnson Act.

In general, the total number of party and charter boats available for hire showed little change during the period, although small changes in fleet size occurred at certain ports. Except for the Ocean City, Md., charter-boat fishery for white marlin (see p. 14), there was no marked shift in fishing grounds nor change in fishing methods during the period considered.

Due to differences in methods of compilation and analysis, the fishery within each state is discussed separately.

NEW JERSEY

An inventory of the New Jersey salt-water sport fishery was continued through 1954 by the New Jersey Division of Fish and Game. Data pertaining to the survey area (Atlantic City to Cape May) were obtained from that agency (Younger and Hamer[3]).

The principal charter- and party-boat fleets in southern New Jersey are located at Atlantic City, Wildwood, and Cape May. Pertinent summary data are presented in table 14. In general, there has been little change in this fishery since 1953. Information on species composition of the catch in 1954 is given in table 15. Catch per unit effort data for the principal species were

[3]Inventory of New Jersey's salt water sport fishery, 1954. By Roy R. Younger and Paul E. Hamer, New Jersey Division of Fish and Game, Trenton, N. J. Report Dingell-Johnson project F2R, 24 pp. (mimeo.)

Table 14,--Summary data, southern New Jersey ocean party- and charter-boat fisheries 1954

Item	Party	Charter
Number of boats	80	16
Average number of fishermen per trip	16.3	4.3
Number of fishermen interviewed	897	108
Number of fish caught	14,812	1,105
Number of fish per man	16.5	10.2

Table 15.--Species composition, southern New Jersey ocean party- and charter-boat fisheries, 1954

Species	Party boats		Charter boats	
	Numbers of fish	Percent	Numbers of fish	Percent
Bluefish	--	--	785	71.0
Bonito	--	--	144	13.0
Porgy	10,041	67.8	--	--
Sea bass	2,709	18.3	73	6.6
Tautog	160	1.1	21	1.9
Red hake	560	3.8	62	5.6
Fluke	375	2.5	18	1.6
Weakfish	951	6.4	1	0.1
All other	16	0.1	2	0.2

Table 16.--Catch per man, New Jersey ocean party- and charter-boat fisheries 1954

Month	Party boats: Number of fish per man; all species combined	Charter boats: Number of fish per man; all species combined
April	--	19.2
May	8.5	13.5
June	12.8	18.7
July	6.5	10.2
August	7.8	8.1
September	5.4	21.7

unavailable; however, table 16 furnishes some measure for all species combined. Since there was no record of the number of hours fished, further effort data cannot be calculated. A report by Younger and Zamos (1955) reviews the marine sport fishery in New Jersey, but contains no further information on the southern New Jersey fishery.

DELAWARE

Ocean sport-fishing fleets in Delaware are located at Indian River and Lewes. Summary data respecting the Indian River party-boat fishery are presented in table 17. Data are unavailable for the Lewes fleet.[4]

[4]Salt water sport fishery survey. By Franklin C. Daiber, Marine Laboratory, University of Delaware, Newark, Del. Report Dingell-Johnson project (1956), 18 pp. (mimeo.).

Table 17.--Summary data, Indian River, Delaware ocean party-boat fishery

Item	Year 1954	1955	1956	1957
Number of party boats	92	95		91
Number of trips	5,272	4,408	No data available	4,562
Number of fishermen	41,080	35,200		No data available
Average number of fishermen per trip	7.8	8.0		
Man-hours fished	424,000	253,600		
Number of fish caught	1,379,500	910,600		
Fish per man-hour	3.3	3.6		

The number of boats in the Indian River fleet decreased from 101 in 1953 to 92 in 1954 and 95 in 1955.[5] Also fewer trips were reported, while the estimated number of fishermen showed a slight increase due to a revised estimate of the average number of fishermen per trip. The total number of fish caught and the number of fish per man-hour also declined. Using average weights obtained from the Ocean City, Md. charter-boat fishery (table 20), the estimated total production for the Indian River party-boat fleet was 1.5 million pounds, with 3.5 pounds of fish caught per man-hour. This value is lower than the 5.8 pounds calculated for the Ocean City, Md. fishery (table 19). This difference probably resulted from the greater average number of hours spent fishing per trip (10.3 hours for Indian River party boats and 5.4 hours for Ocean City charter boats). No further comparisons can be made between the two fleets since fishing methods, grounds, and species taken are substantially different.

Species composition of the Indian River party-boat catch is shown in table 18. Fishing grounds used by the Indian River fleet have remained the same as described in the previous report (June and Reintjes 1957).

No survey of the sport surf fishery was conducted during the period.

[5] Four year's study of sport fisheries in Delaware. Anonymous, Marine Laboratory, University of Delaware, Newark, Del., Report Dingell-Johnson project (1956), 18 pp. (mimeo.).

Table 18.--Species composition, Indian River, Delaware, ocean party-boat fishery

Species	Percentage of catch by number	
	1954	1955
Sea bass	46.9	90.1
Croaker	23.0	--
Porgy	21.2	--
Bluefish	6.0	5.7
All other	2.9	4.2

MARYLAND

The only ocean sport-fishing fleet in Maryland is located at Ocean City. This fleet is composed principally of charter boats which operate in the inshore and offshore waters from May to October, with only occasional trips outside the season. There also are several party or head boats which fish principally for sea bass and porgy on shoals near sunken wrecks.

Boats in the charter fleet engage in three diverse fisheries during the season:

Table 19.--Summary data, Ocean City, Maryland, charter-boat fishery

Item	Year			
	1954	1955	1956	1957
Number of boats	45	50	59	76
Estimated total number of trips	2,818	2,010	3,419	4,688
Average number of hours per trip (hours actually fishing)	5.4	5.2		
Average number of fishermen per trip	4.7	4.3	No data available	No data available
Estimated total catch in pounds	414,000	294,000		
Number of pounds per trip	147	146		
Pounds per fisherman	31.3	34.2		
Pounds per fisherman per hour	5.8	6.6		

Table 20.--Species composition, Ocean City, Maryland, charter-boat fishery

Species	Percentage of catch by weight		Average weight in pounds
	1954	1955	
Bluefin tuna	--	1.2	8.0
Bluefish	74.8	53.8	4.0
Bonito	2.4	15.2	4.0
Dolphin	0.8	6.3	4.5
Little tuna	0.8	1.8	5.0
Porgy	4.9	3.4	0.8
Sea bass	1.5	--	1.0
Weakfish	0.3	1.2	1.0
White marlin	13.9	14.6	55.9
All other	0.6	2.4	--

(1) hand-line fishing for porgy, sea bass, and weakfish in the inshore waters near shoals and wrecks, (2) troll-line fishing for bluefish and other pelagic species from 2 to 20 miles offshore, and (3) troll-line fishing for white marlin from near-shore to over 50 miles offshore. Oftentimes trolling for white marlin and bluefish will be conducted during the same trip, usually after several hours of unsuccessful fishing for shore species.

Summary data for the charter-boat fishery are presented in table 19. Except for the increased number of boats, relatively little change has occurred in the fishery. The marked decline in the number of trips and resulting catches in 1955 apparently was due to the tropical cyclones which threatened that locality during August and September. Other than a record of the number of boats and trips, no data were available for the 1956-57 seasons.

Species composition of the catch, given in table 20, shows that bluefish and white marlin dominated the fishery in 1954 and 1955, with the frequent occurrence of bonito and dolphin in 1955. Landings of white marlin for 1954-57 are given in table 21.

Waters fished by the Ocean City fleet extend from Fenwick Island Light to Winter Quarter Lightship and to a distance of 50 miles offshore in a southeasterly direction from Ocean City Inlet. It was noted that, in

Table 21.--White marlin landings, Ocean City, Maryland

Year	1954	1955	1956	1957
Number of fish	1,023	520	1,616	1,062

recent years, charter-boat fishing for white marlin has been conducted at greater distances from shore as vessels with improved cruising speed and range entered the fishery.

CONCLUSIONS

The survey area lies in the geographical center of the Middle Atlantic Bight, a region characterized by numerous estuaries emptying huge quantities of nutrients onto a wide Continental Shelf. It supports large populations of resident species and seasonal concentrations of migratory fishes. Production of finfish and shellfish in the area appears to be the highest per unit area in the Western Hemisphere. Despite the present high yields of the established fisheries, the fishery resources of the area appear to be underexploited and underutilized for the following reasons: (1) many of the species reported from the area are not captured in any quantity by fishing methods now in use, (2) so-called "trash" species are discarded at sea because of no available utilization for food or industrial products, (3) during seasonal abundance of some species, viz., porgy, squid, sea herring, whiting, and red hake, fishing is curtailed, and catches are limited due to little or no market demand.

The fishery resources of the area fall into four loosely associated groups, viz., (1) resident benthic, (2) sedentary benthic, (3) migratory coastal, and (4) migratory pelagic (Rounsefell and Everhart, 1953). The resident benthic species, which include fluke, sea bass, butterfish, and porgy, are exploited throughout the year by one or more of the following gears: otter trawl, pot, pound net, and hand line. Of these species, only sea bass appears to be exploited at a level approaching maximum. The sedentary benthic species include the surf clam and

scallop and comprise the only ocean shellfish resources presently being utilized within the area. However, a measure of the magnitude of these resources and others, such as the ocean quahog and ocean hard clam, await exploration and further gear and market development. The migratory coastal species include the Atlantic menhaden, croaker, cod, whiting, weakfish, spot, squirrel hake, and bluefish. Although these species contribute substantially to the fish production of the area, they fluctuate greatly in abundance and generally have caused greater instability in the fishing industry than any other component of the total resource. Most migratory pelagic species, including tunas, sharks, round herring, sand eel, squid, and many others, apparently abound along the Continental Shelf, but at present, are unexploited.

The otter-trawl fishery, which contributes most foodfish landings, depends almost entirely upon four species: fluke, porgy, sea bass, and weakfish. Yet most catches include numerous other species which, at present, are discarded (usually at sea) because there is no market for them. Daiber,[6] for example, found that of the 43 species identified in samples from otter-trawl catches in Delaware Bay, 26 were considered "trash." This author stated that, at times, discarded species constituted the major portion of the catch by weight. These inefficient and wasteful practices have resulted in enormous losses to the fishermen in recent years. Complete utilization of the catch, on the other hand, could benefit the fishermen through establishment of a year-round industry based on canned, frozen, and reduced fishery products and thus would increase the return per unit of raw material produced. Biological and technological studies, particularly on the resident benthic species, would be of considerable help in establishing this fishery on an efficient and profitable production basis.

The surf-clam fishery developed and expanded to occupy a position of major importance in the area during the period of the survey. Initial, heavy exploitation of near-shore beds resulted in a marked decline in production, followed by a shift to more distant grounds. Recent production has been curtailed by market demand and the operational limitations of the hydraulic dredge in the search for new fishing grounds. Despite the apparent heavy fishing mortality on virgin stocks, it appears that surf-clam beds will recover if left alone. Fishermen have reported that if heavily exploited beds were allowed to remain undisturbed for 2 or 3 years, they would again produce harvestable clams in fishable quantities. This opinion was substantiated by logbook records that showed the return to productive fishing on clam beds after several years of abandonment. It is not known, however, whether this apparent recovery was due to the growth of new seed stock, or to vertical or horizontal movements of surf clams onto the grounds. Although the surf-clam resource within the area is limited, it appears to be capable of supporting the fishery at present levels of fishing. However, exploratory fishing, to ascertain the depth and areal distribution of virgin beds of mature clams, together with a study of the life history and biology are needed before any major expansion of the fishery can be expected.

Many of the traditional methods of commercial fishing, viz., purse seine for food fish, pound net, drift gill net, trawl line, hand line, and troll line are dwindling in importance, and some may soon disappear entirely from the area. Much of the equipment employed in these fisheries has become obsolescent, and there has been little replacement of worn-out gear. As a result of the decline of these diverse fisheries, certain species such as mackerel, cod, bluefish, and tunas, which are not taken in appreciable numbers by other fishing methods, probably are not being fully utilized within the area.

It is concluded that the area considered constitutes one of the most productive fishing grounds in the Western Hemisphere. Nevertheless, it appears capable of producing much greater quantities of marine products than are now being utilized. With the possible exception of Atlantic menhaden and sea bass, all species inhabiting these waters seem to be underexploited. The greatest potential lies in development of a year-round fishery for the resident benthic species for canned, frozen, and reduced fishery products.

[6] Trawl fishery investigations. By Franklin C. Daiber, Marine Laboratory, University of Delaware, Newark, Del., Report prepared for the General Assembly (Delaware) 1955, 44 pp. (mimeo.).

RECOMMENDATIONS

In order to plan full utilization of the existing fishery resources of the area and to develop those which are now underexploited or unexploited, the following recommendations for continuing studies are made:

1. Expand the area for consideration to include the littoral zone (shore to the edge of the Continental Shelf) of the entire Middle Atlantic Bight (Montauk Point, N.Y. to Cape Hatteras, N. C.).

2. Establish a system for the continuing collection and tabulation of catch statistics by date, gear, species, and area of capture.

3. Initiate exploratory fishing and experimental gear studies to define and capture unexploited species and to increase production of established but underexploited fisheries.

4. Undertake further studies on the sedentary benthic shellfishes (particularly the surf clam) and the resident benthic finfishes for purposes of determining their areas of concentrations, movements, and population dynamics.

5. Initiate technological studies aimed at complete utilization of the catch from the area.

In view of the increasing number of proposals for disposing of waste substances into the ocean waters within the immediate survey area, the following considerations are of primary importance:

1. In order to fulfill a reasonable policy of noninterference with established fishing practices and grounds, a survey of the existing fisheries should be made prior to the initiation of any waste-disposal operations.

2. Detailed knowledge of the nearshore circulation, including the effects of estuarine water transport, will be required in order to determine the existing currents which would affect dispersion of waste products.

3. Monitoring of the area during and subsequent to any waste-disposal operations should be implemented.

4. Collection and analysis of bottom deposits and bottom organisms should be initiated for purposes of determining the existence of or rate of deposition of harmful substances.

SUMMARY

1. This report concludes a survey of the ocean fisheries off Delaware Bay for the period 1954-57 (includes some data on the 1958 winter fisheries) and constitutes a supplement to a report for the period 1946-53 (June and Reintjes 1957).

2. The major fisheries of the area include: menhaden purse seine, otter trawl, surf clam, and pot. These fisheries produce over 99 percent of the total annual landings of fish and shellfish within the area. The menhaden purse-seine fishery leads all others, accounting for over 95 percent of the total catch by weight. The menhaden fishery is not discussed in this report, since pertinent data are available in published reports of the Bureau of Commercial Fisheries Menhaden Investigations, Beaufort, N. C.

3. The otter-trawl fishery is composed of two fleets, an inshore fleet of small to medium-sized vessels (< 50 feet) and an offshore fleet of larger vessels (> 50 feet). During the period considered, fluke, porgy, sea bass, and weakfish comprised over 77 percent of the combined annual landings. Waters immediately off the mouth of Delaware Bay, including Five-Fathom Bank, accounted for 67 percent of the inshore trawl catch, while grounds located in the immediate vicinity of marked indentations of the 100-fathom contour accounted for 36 percent of the offshore catch. Although production of

the trawl fisheries in recent years was downward, factors other than fish abundance probably were largely responsible.

Some vessels of the offshore fleet shift to scallop dredging and lobster trawling during the summer months. Scallop landings averaged about 360,000 pounds and lobster production about 390,000 pounds annually.

4. A surf-clam fishery for canning purposes started in the area in 1949. Annual yield has increased steadily, and in 1957 a fleet of over 100 vessels equipped with hydraulic dredges landed nearly one million bushels. Fishing in recent years has gradually shifted from inshore grounds to deeper waters where virgin beds of these large mollusks frequently are uncovered. Increased fishing effort and improved equipment have increased production although catch per unit of effort has steadily declined.

5. A pot fishery for sea bass produces approximately 1.6 million pounds annually. An increase in fishing effort showed no resulting increase in catch from the grounds now being fished.

6. Combined annual production of the minor fisheries within the area, including purse seine for food fish, pound net, drift gill net, trawl line, hand line, and troll line, amounts to less than 2 million pounds. All have declined in importance within the area, and several (drift gill net and pound net) are on the verge of disappearing.

7. Catches by sport fishermen, estimated at somewhere between 4 and 7 million pounds annually, accounted for a relatively small portion of the total fish production within the area. The sport fishery, however, contributes substantially to the economy of the area by providing a source of income to boat operators, bait dealers, and other recreational interests.

8. General conclusions drawn from the survey are: (a) fish production per unit area is the highest in the Western Hemisphere; (b) many species occurring in the area appear underexploited or underutilized; (c) there is need for exploration and gear development, together with biological and technological studies, to define and more fully utilize the available fish stocks within the area.

9. Recommendations are concerned with: (a) implementation of continuing studies on the marine resources of the area, and (b) selection of waste-disposal areas.

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